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Gas injector

The invention relates to a gas burner or gas injector having a diffuser, which by control actuations can be modified within wide limits as a free jet burner and is suitable in particular for industrial furnaces with regenerative air preheating, in particular those which have an air supply arranged separately from the fuel gas.

It is known that primary NOx-reducing measures in relation to conventionally heated high temperature tank furnaces, in particular in relation to glass melting tank furnaces, are particularly effective in relation to the technology of introducing fuel. Admittedly major efforts have been undertaken in order to optimise furnace geometry and the design of the combustion air supply in terms of pollutant emissions, but not least by virtue of the long installation service lives of more than 10 years in which structural conditions are fixed, those measures are only very late in taking effect, they are greatly limited in terms of their number and misguided developments can only be reversed after the end of the furnace campaign. It is also known that primary NOx-reducing measures, if technologically correctly applied, are linked to an energy saving, an increase in output, a prolongation of service life and quality assurance, but also require a degree of sensor system and intelligent automation as well as attentiveness on the part of the operating personnel in order to maintain the high level attained in respect of effectiveness and pollution reduction.

In accordance with the basic idea of NOx-reduction in relation to high temperature processes like glass melting, DE 195 20 650 A1 discloses burner-nozzle block combinations while DE 102 24 769 discloses free jet burners with an opening angle around 20° and a minimum mouth diameter of 70 mm in a cylindrical burner insert bore without subsequently arranged nozzle block, which, by virtue of low-turbulence introduction of fuel gas, produce delayed mixing of fuel gas and combustion air and have achieved acceptable NOx-reduction effects, with reduced flame root temperatures in individual applications, with respect to the starting level.

Structures as in DE 102 24 769 do not have any possible ways of reacting to fluctuations in throughput in the typical output range but are equipped with turbulence-generating central nozzles which, bearing against the gas supply pipe internally, are operative only in the forward position and there cause rapid distancing from the NOx-reducing mode of operation. Solely reducing the cross-section of the diffuser root is not sufficient to adapt the technologically required flame shape in direction and length to changed fuel throughputs.

With a low throughput the problem which arises is that the gas discharge speed falls drastically, whereby the separately supplied combustion air, by virtue of its markedly higher impulsion and momentum, can interfere with the gas jet in such a way that the free jet characteristic is lost and the desired positioning of the flame in relation to the material to be heated, which is determined by direction and length, can no longer be actively influenced. In an extreme case the combustion air sucks the fuel gas out of the injector mouth and the originally intended delayed mixing and starting reaction already starts directly at the breakaway edge of the combustion air supply. The advantage of the previously known solution, namely arranging the injector mouth without subsequently arranged burner nozzle block in the combustion chamber in order to avoid contact of the intermittently supplied fuel gas with the refractory material, as occurs in the construction of DE 195 20 650 A1, is thus nullified.

EP 0 513 414 B1 discloses apparatuses which provide for different flow conditions by means of axially displaceable conical nozzles directly at the main discharge nozzle.

Solutions as in EP 0 513 414 B1 suffer from the disadvantage that the gas jet which is to be set with complicated and expensive conical nozzles does not have the discharge paths which are required for optimum delayed mixing, and the downstream-disposed nozzle block additionally causes turbulence.

The technology of introducing fuel gas, relative to the air supply which has long been structurally fixed, suffers in the case of the known solutions from in part considerable disadvantages which give rise to risks in regard to the refractory material and thus the product quality and the installation service life or which allow an NOx-reducing mode of operation in an only narrow range.

Thus the known solutions can no longer meet the increased demands in terms of quality of heat transmission of the flame to the material to be heated, the degree of NOx reduction and the flexibility of firing of a modern production installation. With an increasing approach to the thermodynamic optimum of heat transfer and pollution reduction, there is an increasing need for simple, manageable and reproducible instruments, keeping that optimum stable and fully transforming the advantages into economic and ecological benefits.

Therefore the object of the invention is to avoid the disadvantages of the known procedures but at the same time maintain the advantages of the undisturbed free jet with a simultaneous enlargement in the working range.

In accordance with the invention that object is attained by a gas injector having the features of claim 1. Advantageous configurations of the invention are set forth in the appendant claims.

In that respect the concept of the invention in terms of the design configuration of the injector is based on the diameter ratio of the diffuser and the introduction of a double free jet procedure. With the novel concept of closely restricting the diameter ratio of the mouth and the feed pipe, it is possible in virtually every situation of use to impart a low-turbulence free

jet characteristic to the flow of gas in a very short time, without having to tolerate the above-mentioned disadvantages. The characteristics of the long diffuser are not determined and limited by absolute dimensions of the mouth but represent conditions in respect of the fuel gas supply, which are optimum in terms of flow technology, in wide ranges. Time-consuming trial-and-error processes for determining the optimum operating point are eliminated and the parameters can be easily transposed to other installations. In tests which were conducted the running-in phases of several months could be reduced to a few weeks. In particular the risks to the refractory material which can occur due to improved heat transfer and the accompanying reduction in fuel throughput and reduction in the gas impulsion and momentum are excluded. Adverse effects such as washing-out phenomena and surface spalling effects which only become apparent after between 1 and 2 years can thus be avoided.

The invention is described in greater detail hereinafter by means of an embodiment with reference to the drawings in which:

Figure 1 shows a lateral view in section of the front part of a gas injector according to the invention which is fitted into a burner insert opening,

Figure 2 shows a view in section through the entire gas injector according to the invention with a first embodiment of a closure and regulating device, and

Figure 3 shows a view in section through the entire gas injector according to the invention with a second embodiment of a closure and regulating device.

Figure 1 shows the position of a gas injector according to the invention which is determined by the position of the mouth of a long diffuser 3 at the end of a burner insert opening 6. The gas injector according to the invention is provided with a gas supply pipe 1 and a mouth 2, wherein the communication between the gas supply pipe 1 and the mouth 2 forms the long diffuser 3 with a free jet opening angle. The configuration according to the invention of the long diffuser 3, determined by the diameter ratio of the gas supply pipe 1 and the mouth 2 which is

less than three, ensures low-turbulence introduction of fuel in a wide range of uses.

The stability and flexibility of the low-turbulence fuel supply is enhanced to a high degree by the introduction of a second free jet in the root of the diffuser 3. That is implemented by a central nozzle pipe 4, the mouth of which is also in the form of a free jet opening angle, preferably of about 20°. The notional prolongation 7 of the generatrix of the mouth 8 of the central nozzle pipe 4 goes directly into the generatrix of the long diffuser 3. In that case the central nozzle pipe 4 is preferably arranged in the gas supply pipe 1, providing an annular gap 9 between the central nozzle pipe 4 and the inside periphery of the gas supply pipe 1. Preferably there is also a closure and regulating device 11 or 16 for regulating the partial flows through the central nozzle pipe 4 and the annular gap 9. That permits an additional modification in the ratio of the partial flows through the central nozzle pipe 4 and the annular gap 9 and permits the setting of a low-turbulence free jet at the most widely varying fuel throughput rates as division of the partial flows occurs at such a distance relative to the mouth 8 that both pass in a low-turbulence condition into the long diffuser 3 and thus, in spite of differing input parameters, deploy the full heat transfer efficiency and NOx-reduction effect.

The arrangement of a water-cooled ring 5 which protects the mouth 2 which is mostly made entirely of metal and air-cooled from thermal wear also has a stabilising and flexibility-enhancing effect. Cooling water connections 14 lead the coolant to the mouth region of the injector. The water-cooled ring 5 is closed by a partition between the feed and return of the cooling water connection 14, whereby the cooling water flows once through the hollow body of the ring and issues again. At the same time the mouth cooling ring 5 forms an admittedly contact-free but close closure relative to the burner insert opening 6 and thus prevents unwanted ingress of infiltration air. The burner insert opening 6 is preferably of a conically tapered configuration in the flow direction so that vertical and horizontal angular deflection of the entire injector in the free space 10 disposed therebehind becomes possible so that the direction and position of the fuel

free jet can be determined relative to the incoming combustion air and relative to the material being heated. The provision of a burner insert opening 6 which conically tapers in the flow direction ensures and expands the specific use of the free space 10 as an optimisation parameter without interfering with the outflowing free jet, as is known from previous burner-nozzle block combinations. In order to ensure full availability of the free space 10 for angular deflection of the injector, the water-cooled ring 5 is preferably rotatable about the axis of the injector, whereby the cooling water connection 14 can be respectively mounted in the part of the free space 10, which is not involved in the angular deflection.

Division of the partial flows which is provided in accordance with a preferred embodiment in the central nozzle pipe 4 and the annular gap 9 between the gas supply pipe 10 and the central nozzle pipe 4 can be effected within or outside the gas supply pipe 1, with suitable closure and regulating devices being provided for that purpose.

Figure 2 shows regulation within the gas supply pipe 1. Arranged between the gas pipe 1 and the central nozzle pipe 4 is an axially displaceable cone 11 which co-operates with an inclined surface of the inside wall of the gas supply pipe 1 and which can regulate the annular gap 9 between the two and in the extreme setting completely close it. Axial displacement of the cone 11 can be effected by way of a spindle 12 or other suitable devices which are set in movement by a spindle drive 13. Complete closure of the annular gap 9 represents the lower working point of the injector, that is to say 100% of the gas flow flows through the central nozzle pipe 4. Complete opening of the annular gap 9 by retraction of the cone 11 in opposite relation to the flow direction represents the upper working point with full fuel throughput. The intermediate positions can be steplessly set by displacement of the cone 11.

In the second case which is shown in Figure 3 the overall gas flow is divided by conduit means before passing into the gas supply pipe 1. A secondary gas supply pipe 15 branches off an overall gas supply 17 which opens into the gas supply pipe 1, and directly charges the central nozzle pipe 4. Disposed in each of the two supply conduits is a valve 16 for

adjusting the respective partial gas flow. Both partial flows, both that through the annular gap 9 and also that through the central nozzle pipe 4, can be 100% shut off by the separately arranged valves 16 and can be steplessly adjusted therebetween. Other closure and regulating devices are possible.

List of references used

1 gas supply pipe
2 mouth long diffuser
3 long diffuser
4 central nozzle pipe
5 water-cooled ring
6 burner insert opening
7 notional prolongation of the generatrix of the central nozzle pipe
8 mouth central nozzle pipe
9 annular gap
10 free space
11 cone
12 spindle
13 spindle drive
14 cooling water connection
15 secondary gas supply pipe
16 valve
17 overall gas supply